

ACR Grazing Land and Livestock Management (GLLM) Methodology

***SB 1383 Subgroup #1: Fostering Markets for Non-Digester Projects
Sacramento, CA
May 21, 2018***

- Comprehensive and flexible accounting framework for broad range of beef and dairy GHG mitigation activities
- Focuses on five primary GHG sources/sinks: enteric, manure, fertilizer, fossil fuel, and biotic sequestration
 - Provides modular accounting methods for each of these
 - Tiered approach based on size of impacts
 - Not all necessarily required; depends on project activity
- Non-prescriptive
 - Producer decides what practice change to undertake
 - Methodology doesn't prescribe what to do, only how to do the accounting, using applicable modules



Applicability Conditions

- Dairy and beef operations only
- Project lands managed for grazing/livestock in the project scenario
- Example practices:
 - Implement rotational and management intensive grazing in beef and dairy
 - Dietary changes
 - Feed additives
 - Change manure management system
 - Tree planting (silvopasture)
 - Convert cropland to pasture



Framework Module

- Overall structure and functionality of methodology
- Applicability conditions for the methodology overall
- Defining the project boundary (geographic boundary, temporal boundary, and GHG SSRs included/excluded from accounting)
- Demonstrating additionality
- Formula to calculate ERTs using output parameters of other modules
- Monitoring requirements

Project Boundary

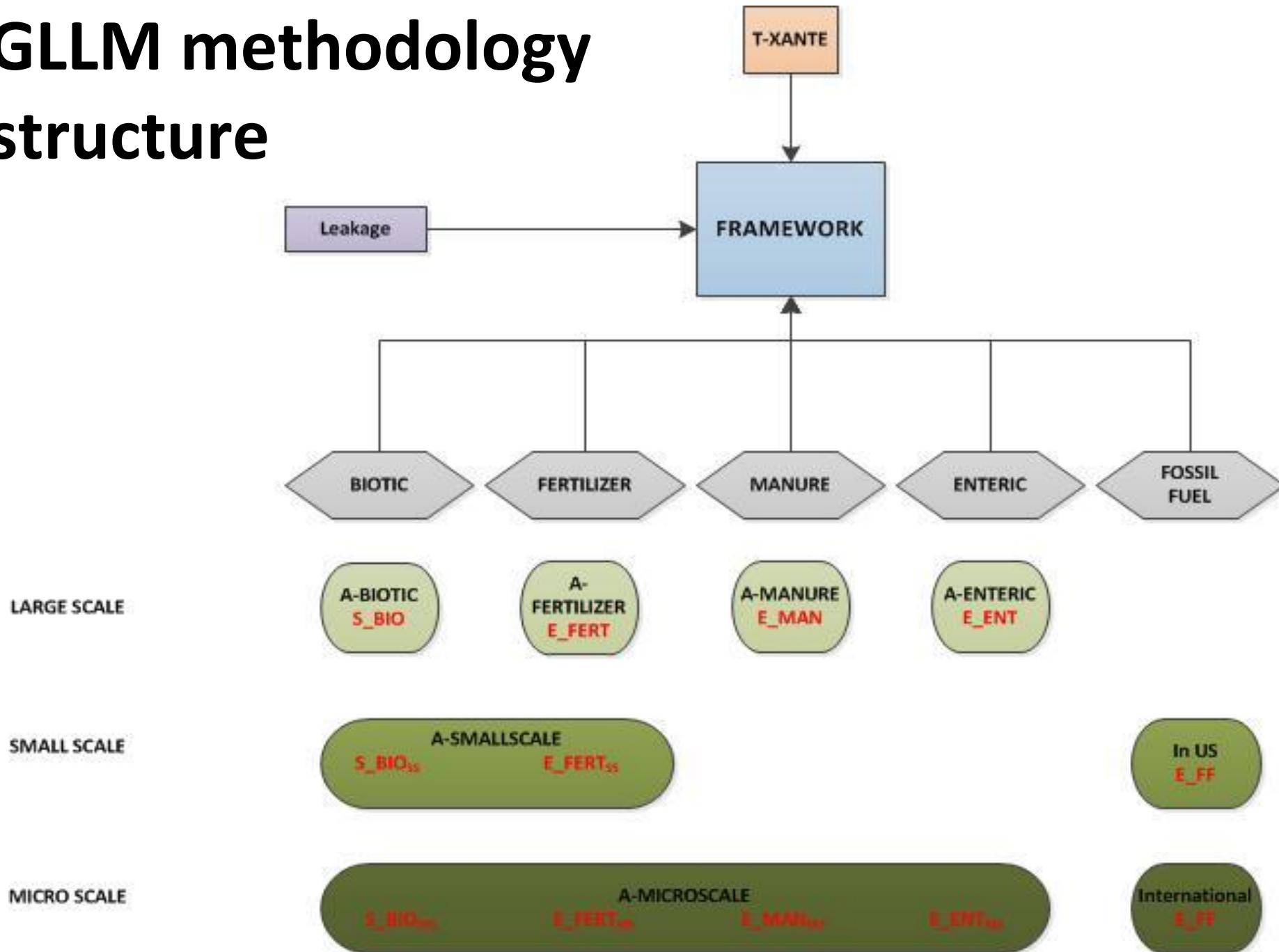
- Facilities and lands where livestock are held, fed and grazed, in both baseline and project scenarios
 - All entities over which Project Proponent has effective control; may span several commercial entities
 - May include analytical units corresponding to animal management rather than land areas
- May not exclude lands/facilities where emissions increase due to project activity
- May include multiple areas, facilities, owners, and start dates (aggregated)

Accounting Modules

Complexity and data requirements of required accounting method correspond to the scale of impacts expected in a particular SSR

T-XANTE	Ex ante estimate of net reductions directs user to A-MICROSCALE, A-SMALLSCALE, or full accounting module
A-MICROSCALE	Excel tool – simple emission factors, low data requirements when estimated impacts on a SSR are <5,000 tCO ₂ e/y
A-SMALLSCALE	Used in U.S. for biotic, fertilizer and fossil fuel impacts between 5,000 and 60,000 tCO ₂ e/y. (uses IPCC Tier 2 methods)
A-ENTERIC	Used for impacts >5,000 tCO ₂ e/y
A-MANURE	Used for impacts >5,000 tCO ₂ e/y
A-FERTILIZER	Used in U.S. for impacts >60,000 tCO ₂ e/y and outside US for impacts >5,000 tCO ₂ e/y
A-BIOTIC	Used in U.S. for impacts >60,000 tCO ₂ e/y and outside US for impacts >5,000 tCO ₂ e/y
L-GLLM	Activity-shifting and market effects leakage emissions
T-RISK	Tool for calculating buffer contribution for biotic sequestration

GLLM methodology structure



Scaled Approach to GHG Accounting

The magnitude of estimated GHG impacts determines the accounting approach



Need an accounting approach before you know the magnitude of estimated GHG impacts

start here

MICRO SCALE

SMALL SCALE

LARGE SCALE



< 5,000 t CO₂e/y



< 5,000 t CO₂e/y

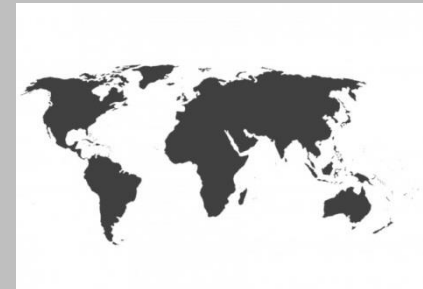


5,000 to 60,000 t CO₂e/y

AND
Direct FF Emissions < 60,000 t
CO₂e/y



> 60,000 t CO₂e/y



> 5,000 t CO₂e/y

Net ER Calculation

$$ERT_GLLM_t = E_ENT + E_MAN + E_FERT + E_FF + (S_BIO * (1 - Buffer\%)) - E_LK$$

- E_ENT , E_MAN etc. from applicable module (large, small or micro scale)
- $Buffer\%$ from T-RISK tool and is only a deduction from activities with biotic sequestration
- E_LK from L-GLLM and includes both activity-shifting leakage (if required) and market leakage

MICROSCALE Module

MICRO SCALE



< 5,000 t CO₂e/y



< 5,000 t CO₂e/y

- Excel spreadsheet-based tool
- Simplified, automated GHG accounting procedures applied
- Provides a preliminary estimate of expected emission reductions from each source category:
 - Biotic Sequestration (S-BIO)
 - Enteric Fermentation (E-ENT)
 - Manure Management (E-MAN)
 - Fertilizer Use (E-FERT)
 - Fossil Fuel Use (E-FF)
- Output is based on data inputs provided by user for baseline and project scenarios
- Results of A-MICROSCALE → T-XANTE

- Based on IPCC Tier 1 accounting methodology

A-MICROSCALE



Parameter Name: S_BIO
Parameter Description: Net microscale biotic sequestration/emissions (t CO₂e)
Calculated value: 33,229 t CO₂e yr⁻¹

Instructions: Enter data into the light blue cells for both baseline and project scenarios. Use the unit converter box in the upper right as needed.

Select from drop-down menus.

Geographic Region: North America
 Climate Region: Warm Temperate Moist
 Soil Type: Low Activity Clay
 Size of Project Area: 5,000 ha

Land Cover Type
 Grassland Management
 Grassland Inputs
 Cropland Management
 Cropland Inputs

BASELINE DATA	PROJECT DATA
Long Term Cultivated Crop	Grassland
N/A	Improved
Medium	High
Full Tillage	N/A
Medium	N/A

Are you planting trees in the project area?

No

Land Cover Type
 LT Cultivated Crop: Continuously managed > 20 yrs with annual crops.
 ST Set Aside: Temporary set aside of annual crop or other idle cropland.
 Grassland: Ranges from extensively managed rangelands to intensively managed continuous pasture and hay land.



INSTRUCTIONS: Enter data into LIGHT BLUE CELLS for both baseline and project scenarios. Change values in gray cells only if you have project specific data, otherwise leave existing default values as they appear in the cell.

	BASELINE DATA							PROJECT DATA						
	Dairy Cows	Mature females	Mature Males	Calves on forage	Growing heifers/steers	Replacement /growing	Feedlot cattle	Dairy Cows	Mature females	Mature Males	Calves on forage	Growing heifers/steers	Replacement /growing	Feedlot cattle
Number of Animals Produced Per Year	1,000			75	300	150	300	1,000	900	40	75	300	150	300
% of Females that give birth in a year:	90			0	0	0	0	90	80	0	0	0	0	0
Feeding Situation: Enter the % of the year under each feeding situation per animal category.														
Stall-fed/Confined (tethered, pen, barn)	80			80	80	80	80	80	80	80	80	80	80	80
On pasture (confined in areas with sufficient forage)	20			20	20	20	20	20	20	20	20	20	20	20
Grazing large areas (i.e., rangeland)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average Live-Weight of Animal (kg)	600	500	800	185	265	375	415	600	500	800	185	265	375	415
Average Daily Weight Gain (kg day ⁻¹)	0.0	0.0	0.0	0.9	0.7	0.4	1.3	0.0	0.0	0.0	0.9	0.7	0.4	1.3
Total Annual Milk Production (kg cow-1 yr ⁻¹)	8,395	1,205	0	0	0	0	0	8,395	1,205	0	0	0	0	0
Fat content of milk: (%)	4.0	4.0	0	0	0	0	0	4.0	4.0	0	0	0	0	0

Feeding Regime: Enter the type and % of each feed in the total annual diet of each animal category.

Select feed name from drop down menu.

[illegible]

Microscale: Manure Management

Parameter Name: E_MAN
Parameter Description: Net microscale manure emissions (t CO₂e)
Calculated value : 402 t CO₂e yr⁻¹

Instructions: Enter data into light blue cells for both baseline and project scenarios.

Geographic Region: North America
Average Annual Temperature: 18 °C

Manure Management System	% of manure managed under each system	
	Baseline	Project
Pasture/Range/Paddock	0	0
Daily Spread	0	0
Solid Storage	100	0
Dry Lot	0	0
Liquid/Slurry with crust	0	0
Liquid/Slurry without crust	0	0
Uncovered anaerobic lagoon	0	0
Pit storage <1 month	0	100
Pit storage >1 month	0	0
Anaerobic digester	0	0
Burned for fuel	0	0
Deep bedding <1 month, no mixing	0	0
Deep bedding <1 month, active mixing	0	0
Deep bedding >1 month, no mixing	0	0
Deep bedding >1 month, active mixing	0	0
Composting - In-Vessel	0	0
Composting - static pile	0	0
Composting - intensive windrow	0	0
Composting - passive windrow	0	0
Aerobic treatment	0	0

Based on IPCC Tier 2 methodology → different manure management systems specified



Microscale: Fertilizer Use

A - MICROSCALE



UNIT CONVERTER

<input type="text"/>	pounds =	<input type="text"/>	kilograms (kg)
<input type="text"/>	acres =	<input type="text"/>	hectares (ha)

Parameter Name:

E-FERT

Parameter Description:

Net microscale fertilizer emissions (t CO₂e)

Calculated value:

-193 t CO₂e yr⁻¹

Instructions: Enter data into light blue cells for both baseline and project scenarios.

Synthetic Fertilizer Application:

Anhydrous Ammonia (NH₃) "Ammonia"

Ammonium Sulfate [(NH₄)₂SO₄]

Monoammonium Phosphate (MAP)

Diammonium Phosphate (DAP)

Ammonium Nitrate (NH₄NO₃)

Calcium Ammonium Nitrate (CAN)

Baseline			Project		
Total Weight Applied (kg yr ⁻¹)	%N	Area of Land Where Fertilizer is Applied (ha)	Total Weight Applied (kg yr ⁻¹)	%N	Area of Land Where Fertilizer is Applied (ha)
15,000	82	5,000	15,000	82	5,000
	21	5,000		21	5,000
	11	5,000		11	5,000
	18	5,000		18	5,000
	34	5,000		34	5,000
	26	5,000		26	5,000

Urea Application:

Amount of urea fertilization (kg yr-1)

0	5,000	0	5,000
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Organic Manure Application:

% of managed manure applied to fields:

100	100
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A-MICROSCALE



Parameter Name:	E_FF
Parameter Description:	Net microscale fossil fuel emissions (t CO ₂ e)
Calculated value:	153 t CO ₂ e yr ⁻¹

Instructions: Enter data on annual fuel quantities into the light blue cells.

	Baseline	Project	Fuel Units	
Ethane	0	0	Gallons	<i>If necessary, change units using drop-down menus.</i>
Propane	0	0	Gallons	
Butane	0	0	Gallons	
LPG	0	0	Gallons	
Motor Gasoline	20,000	5,000	Gallons	
Aviation Gasoline (avgas)	0	0	Gallons	
Other Kerosene	0	0	Gallons	
Gas/Diesel Oil	10,000	8,000	Gallons	
Biodiesel	0	0	Gallons	
Biogas	0	0	Gallons	
Other Liquid Biofuels	0	0	Gallons	

- Fully automated
- Uses results from A-MICROSCALE to display which modules should be used

Is your project located within the continental United States?

MODULE SELECTION FOR YOUR PROJECT:

Emission Category		Module Selection
<5,000 t CO ₂ e	<i>Biotic Sequestration:</i>	A-SMALLSCALE
	<i>Enteric Fermentation:</i>	A-MICROSCALE
	<i>Manure:</i>	A-MANURE
<5,000 t CO ₂ e	<i>Fertilizer:</i>	A-MICROSCALE
<5,000 t CO ₂ e	<i>Fossil Fuel:</i>	A-MICROSCALE

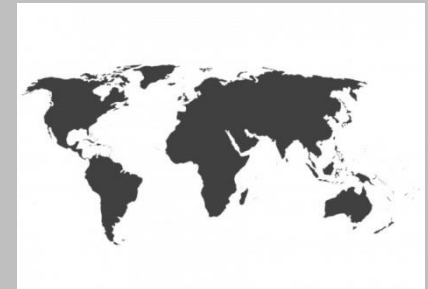
The Large Scale Modules

A-BIOTIC
A-ENTERIC
A-MANURE
A-FERTILIZER

LARGE SCALE



> 60,000 t CO₂e/y



> 5,000 t CO₂e/y

May be elected instead for any or all of the applicable modules

A-BIOTIC: Model

- Examples include Century, DayCent and Roth-C
- Must be studies (e.g. journal articles demonstrating use of model is appropriate in region where it is being applied)
- Model must have potential to determine soil carbon to an identified depth while considering:
 - Crop/grass type and productivity
 - Crop/grass management (including tillage)
 - Livestock presence, type and number
 - Manure applied, produced and management of manure application/production
- Modeling of herbaceous vegetation is an optional capability that must be used where present
- Validation of model required with limited field data sampling at each verification

ACR Tool for Estimation of Stocks in Carbon Pools and Emissions from Emissions Sources (CPES)

- Used to quantify sequestration from trees and shrubs
- Stocks derived from field measurement
- Baseline stocks equal to stocks at start of project

A-BIOTIC: Data Inputs

- Tillage
 - type
 - depth
 - frequency
- Livestock
 - presence
 - type
 - manure application, production and management
- Grass
 - type
 - productivity
 - management
- CPES
 - trees and shrubs (field measurement)

- Divided by livestock sub-category:
 - Lactating cows
 - Dry cows
 - Heifers and steers
- Calculations based on empirical equations developed using animal and feed data collected in open-circuit respiration chambers from 1963 to 1995

A-ENTERIC

Data Inputs

- Number of livestock
- Body weight of livestock
- Information about different feed types:
 - Composition of annual diet (% of each feed)
 - Dietary ether extract
 - Gross energy intake
 - Dietary neutral detergent fiber

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- Calculations based on Dairy GEM
 - Dynamic baseline
 - Emissions dependent on manure system and time of year (ambient temperature)
 - CO₂: methane flaring from enclosed manure storage
 - CH₄: sum of emissions from:
 - Barn floors and open lots
 - Stored manure (covered, uncovered, dry stacks)
 - Manure applied to fields
 - Manure from grazing animals
 - N₂O: sum of emissions from:
 - Barn floors / dry lots
 - Unenclosed storage of manure / stacked dry manure

A-MANURE

Data Inputs

- Type(s) of manure management system(s)
- Quantity of feces produced
- Properties of feces:
 - Volatile solids content
 - Manure pH
- Quantities of manure storage and loss
- Ambient temperatures

A-FERTILIZER Model

- No specific model is endorsed (e.g., DNDC, Daycent)
- Must demonstrate that model is appropriate for climate/agroecological zone in which the project is located
- Output must be the fertilizer-derived emission at a specific point in time

A-FERTILIZER

Data Inputs

- Atmospheric Factors
- Daily meteorology
- Edaphic factors (e.g., clay content, soil pH)
- Cropping factors (e.g., crop type, planting and harvest dates)
- Tillage factors (e.g., date and depth of tillage)
- Fertilizer application factors (e.g., type and application rate)
- Irrigation factors (e.g., # irrigation events, date)



Thank You!

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